AGING SYSTEMS AT SLAC

Matt Gibbs

Accelerator Operations Specialist for LCLS

AGING SYSTEMS AT SLAC

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LCLS, built in 2008

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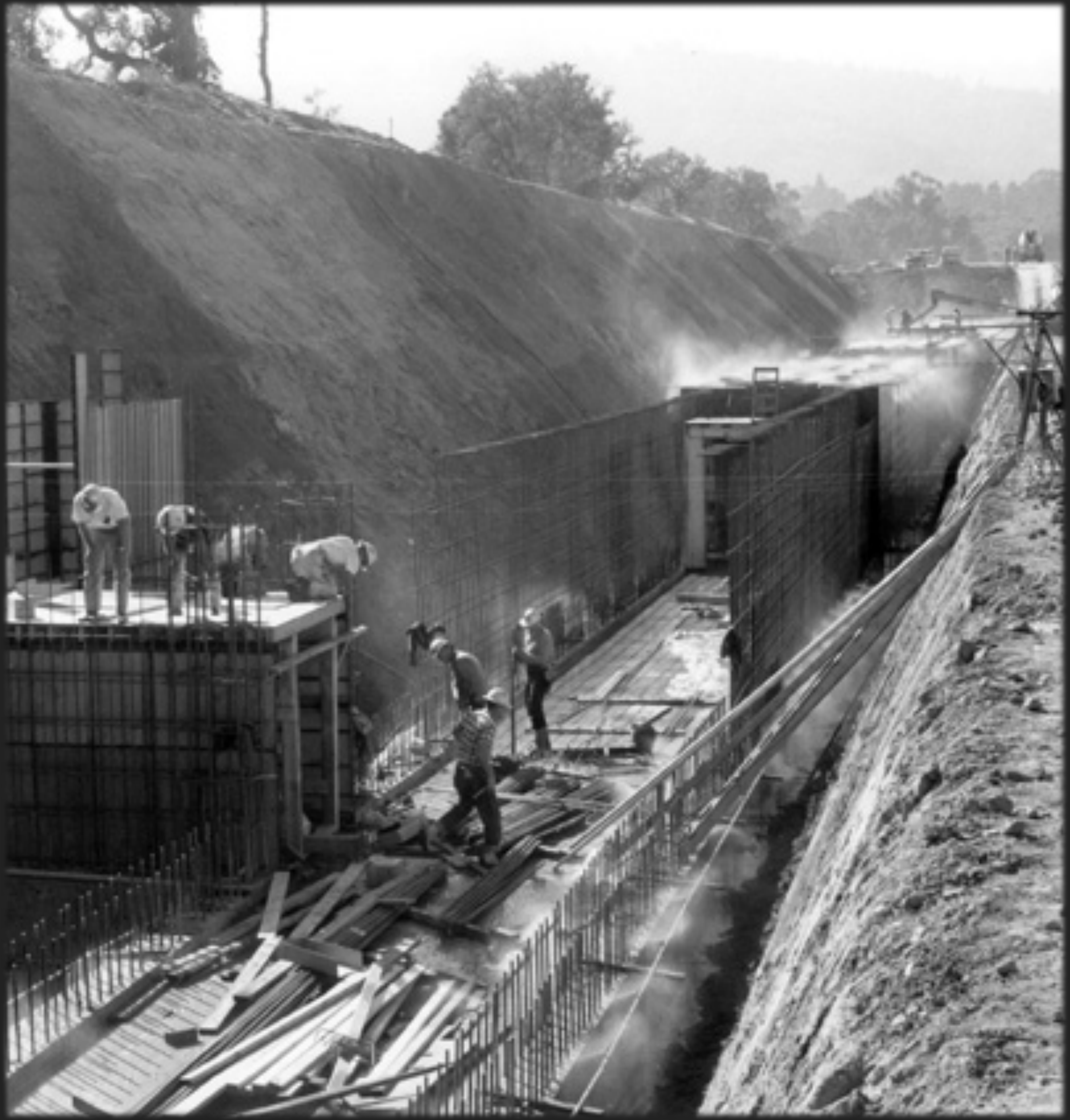
SPEAR3, built in 2004

SLAC IS OLD

- Linac tunnel constructed in 1964 (pictured)
- First beam in the linac in 1966
- Pre-dates computerized control systems
- Pre-dates single-chip CPUs
- Pre-dates Programmable Logic Controllers
- Far surpassed lifespan expectations



AGING SYSTEMS AT SLAC

1966

1974

2010

SLAC TIMELINE

1966	1980	1985	1998	2008	2018
	PEP	SLC Upgrade	PEP-II	LCLS Upgrade	
		"SCP" Control System CAMAC Hardware New Timing System New Machine Protection System		EPICS Control System VME Hardware New Timing System New Machine Protection System	

UPGRADES ADD NEW THINGS, RARELY TAKE OLD ONES AWAY

- As time goes on, the number of different technologies to support grows:
  - Variants on a type of system
  - Software packages
  - “Quirks” to memorize

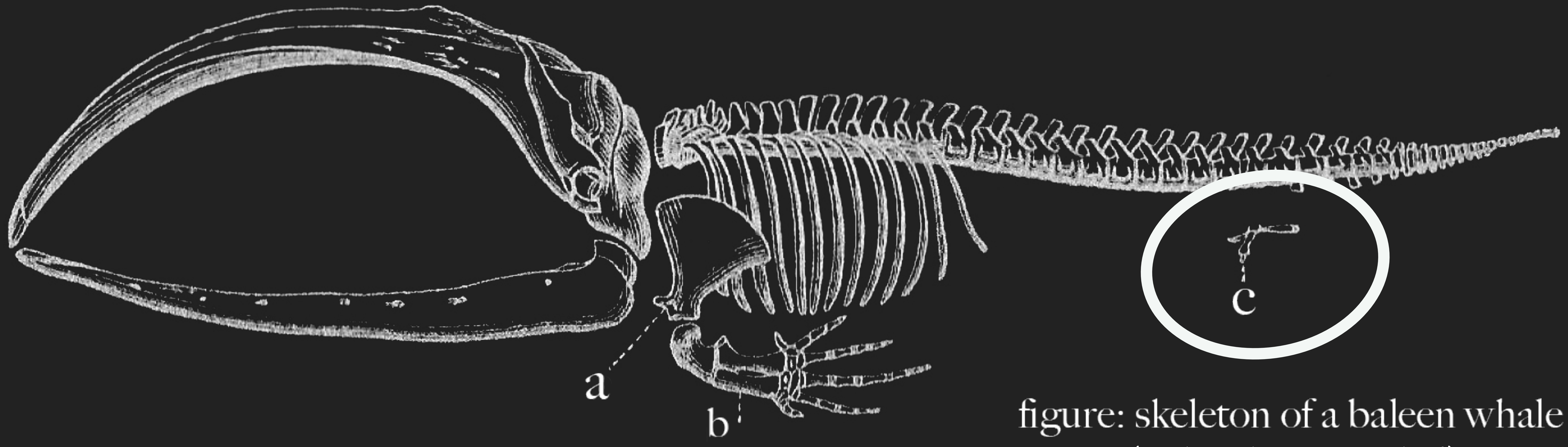


figure: skeleton of a baleen whale
(Pelvic bone circled)

VESTIGIAL SYSTEMS

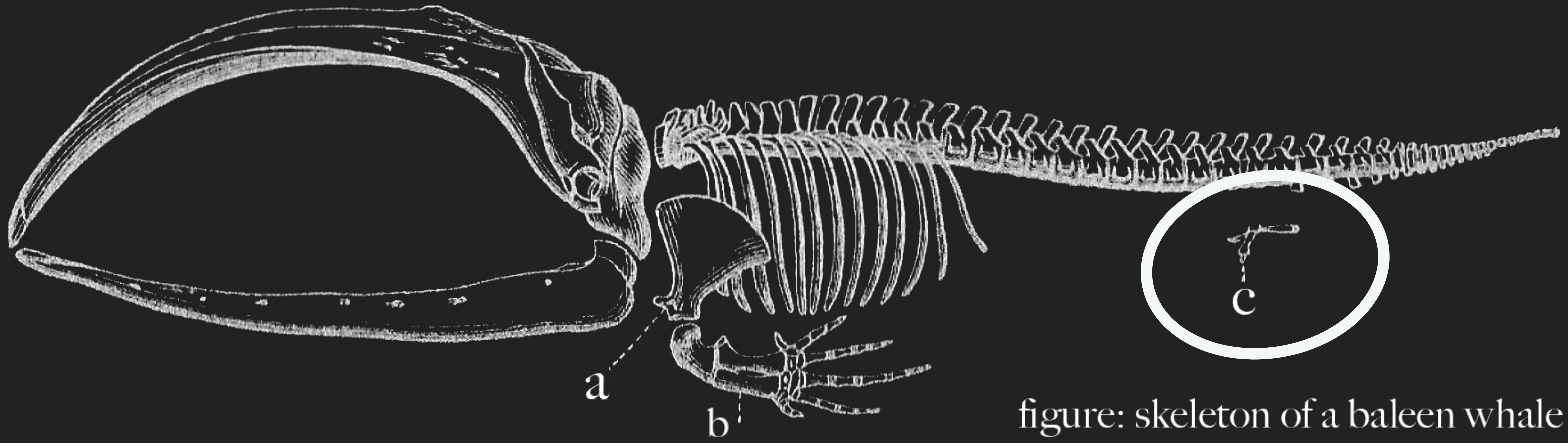
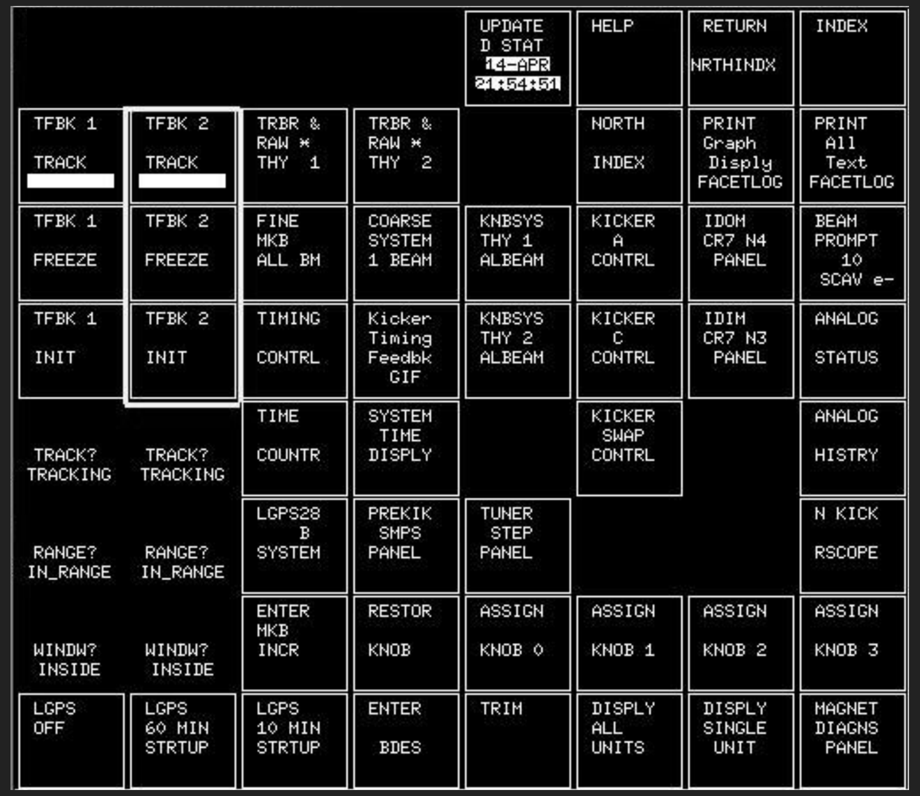


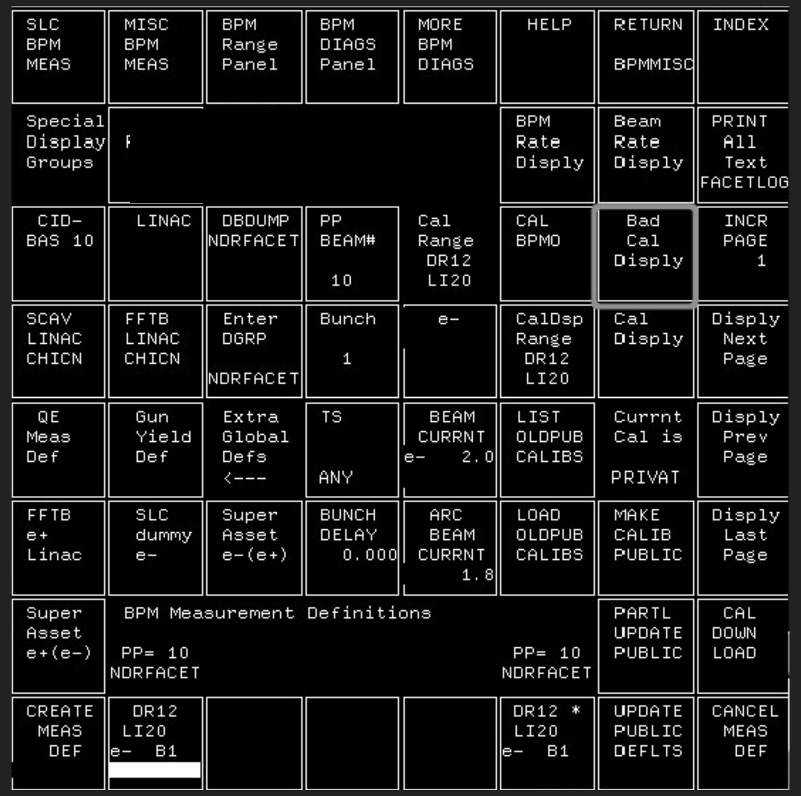
figure: skeleton of a baleen whale
(Pelvic bone circled)

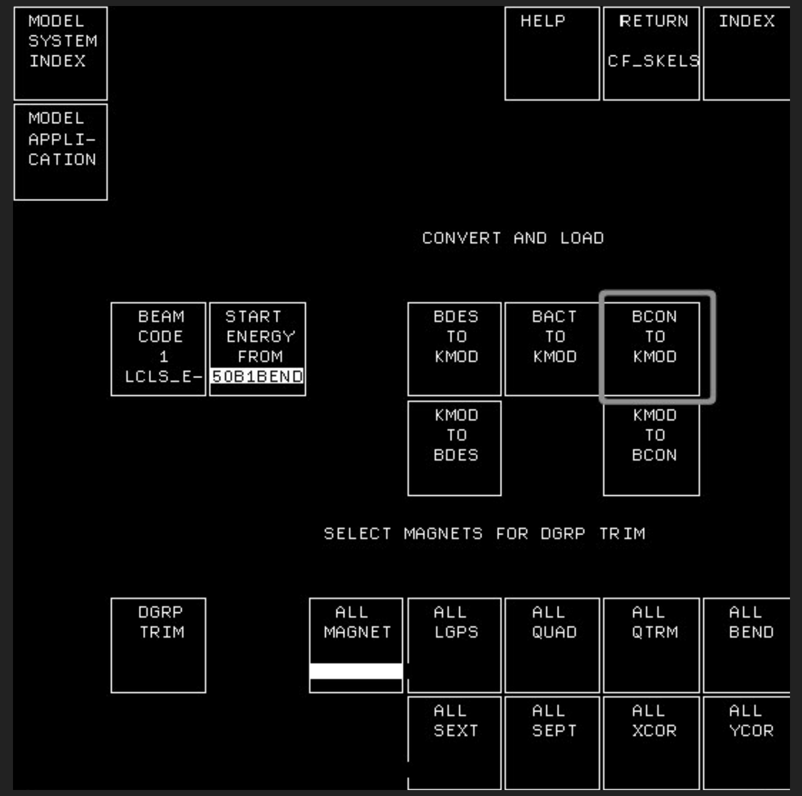
- Control system interfaces for decommissioned equipment
- Obscure equipment that serves no function, but will trip the beam off when it fails

EXAMPLE: PPYY RELAY

- Backup shut-off path for the SLC/PEP-II Machine Protection System's beam loss monitors. Stops broadcasting timing pattern to all devices.
- In the LCLS era, none of the loss monitors tied the PPYY relay existed in areas with beam. However, the relay still had spurious trips a few times per year.
- Status for the PPYY relay, and the reset button, requires navigating through a series of obscure, poorly labeled, visually indistinct panels.







09/28/2018 09:50:49

PPS/BCS Status Display

PPS 21-29: OK PPS 30-MCC: OK PPS UND: OK

09/28	09:18:04	PPS	NEH Hutch 2 Stopper S2.2	NOT_IN
09/28	09:14:55	PPS	NEH Hutch 2 Search Reset	SET
09/28	09:11:48	PPS	XRT Search Reset	NOT_SET
09/28	09:11:41	PPS	XRT ACCESS STATE	CONTROLLED
09/28	09:11:21	PPS	XRT SH2.1	NOT_IN
09/28	09:11:21	PPS	XRT SH2.2	IN
09/28	09:09:06	BCS	B911 BX3/BYD - DTC 1	OK

EXAMPLE: SPEAR3 “WOLF BOX”

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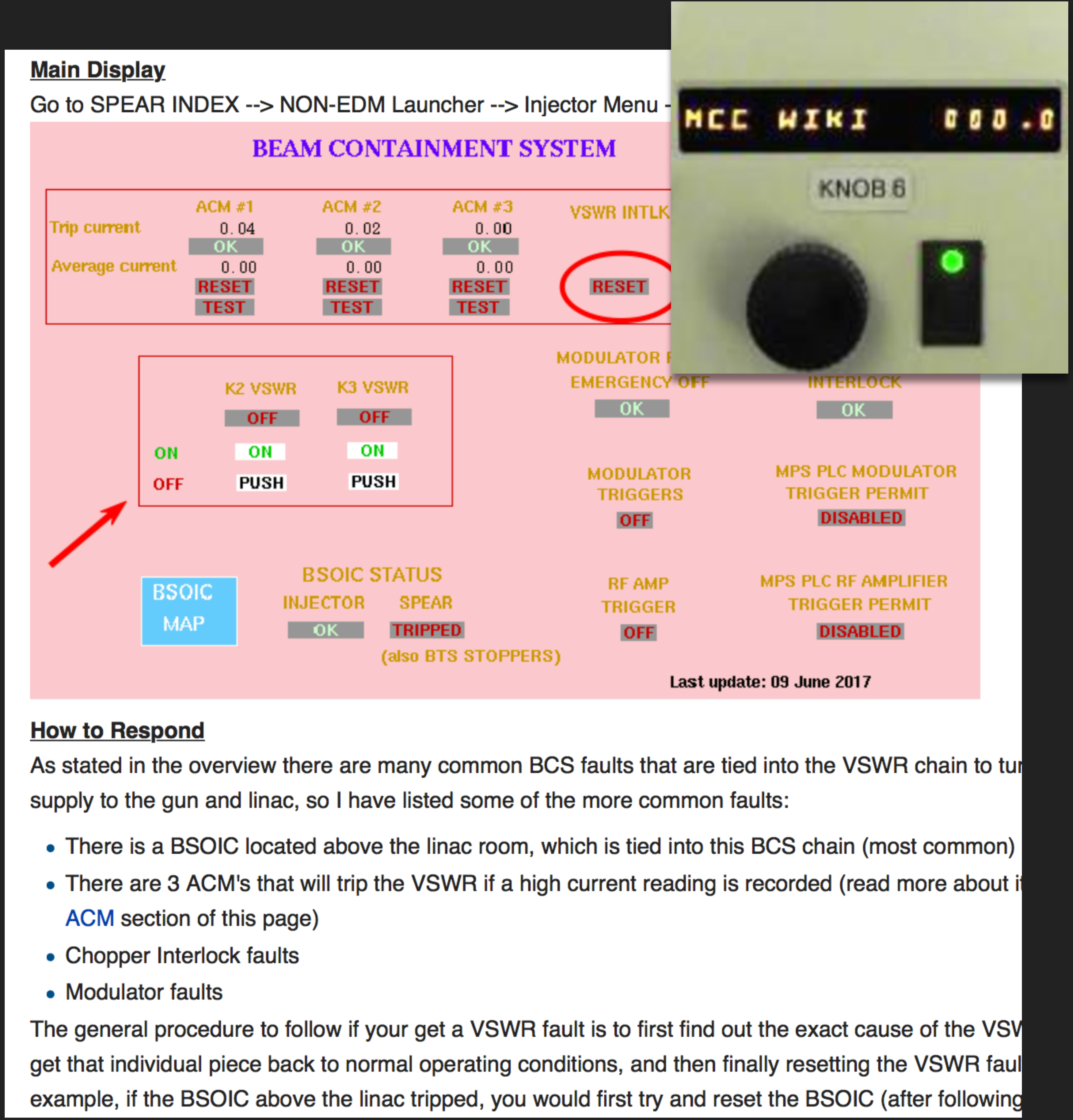
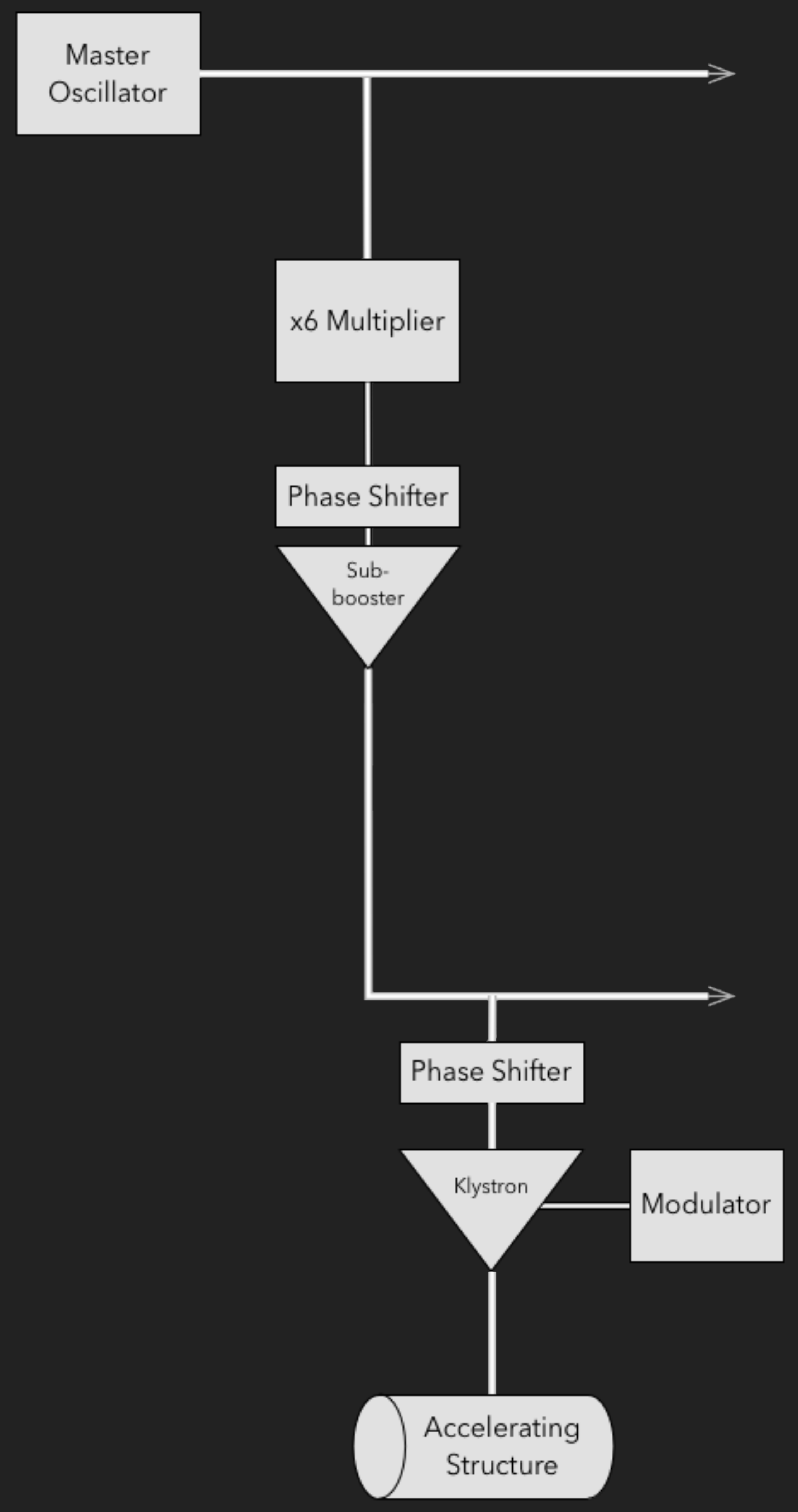
- Linac VSWR (Voltage Standing Wave Ratio) alarm originally indicated a klystron reflected energy issue.
- The VSWR interlock shuts off the linac klystron, which is also a convenient way to shut off the beam.
- Many other systems (Average Current Monitors, Ion Chambers, etc) were wired into the VSWR interlock.
- Reflected energy is almost never a problem, so the klystron’s VSWR is almost never the problem.

"WOLF BOX" DOCUMENTATION

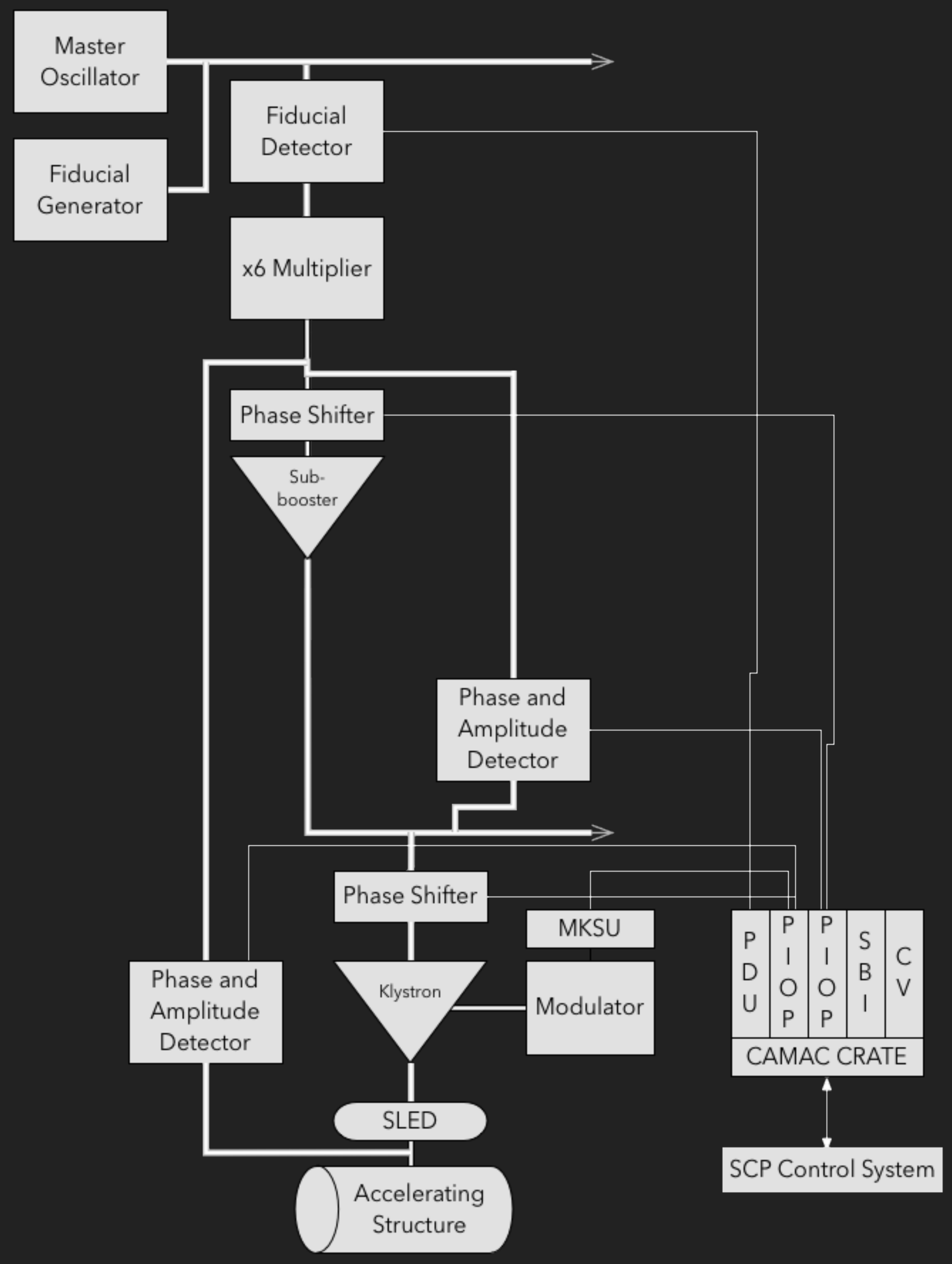
- Extensive wiki documentation for every alarm channel (more than 7000 words!)
- Explains what can cause each alarm and how to respond (who to contact, what to document, how to reset)
- Painstakingly researched and written by a brand-new operator who was fed up with the chaos of the alarm system.





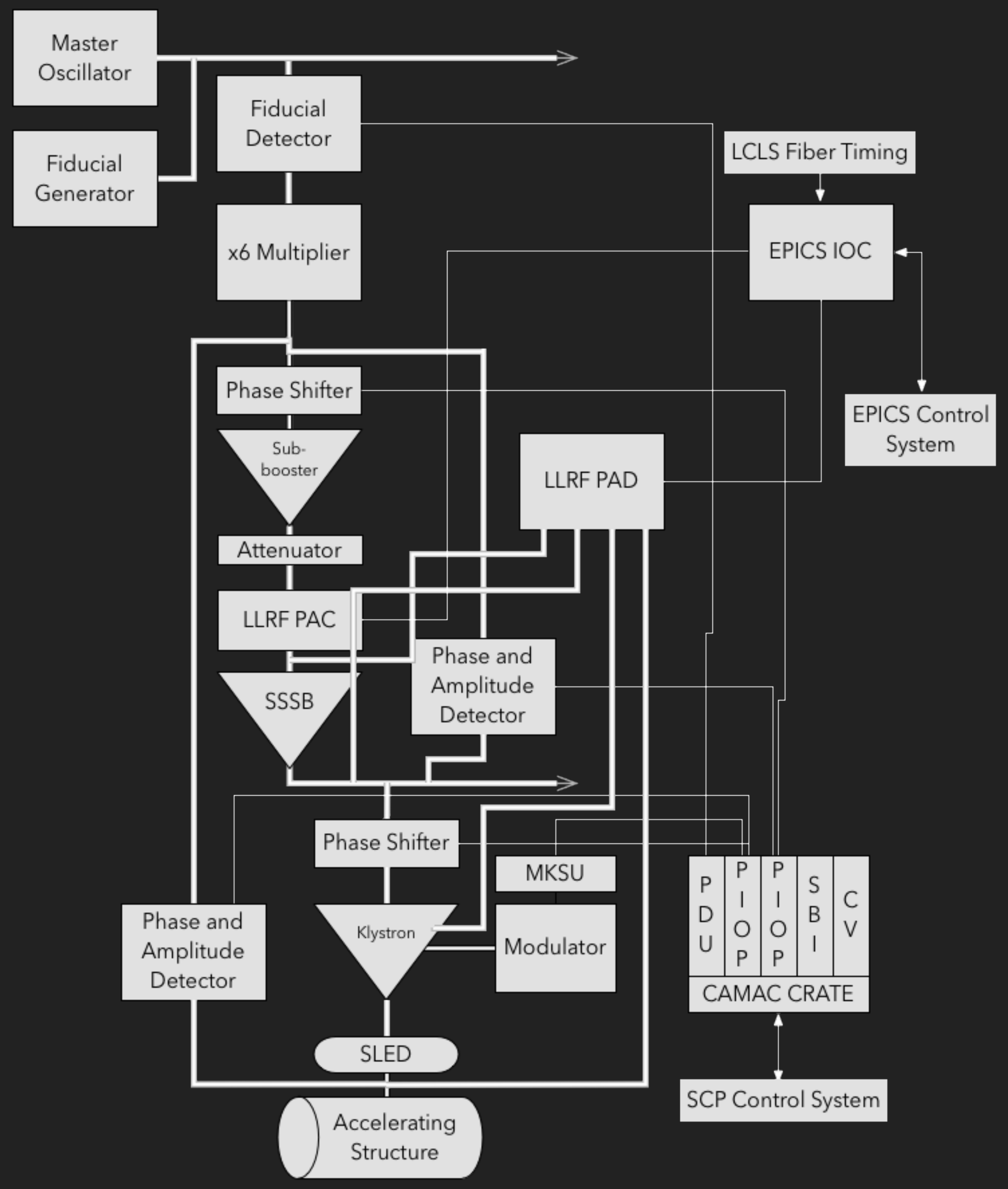
EXAMPLE: THE KLYSTRON SYSTEM

- 8 major components
- Operator interface in control room:
  - One on/off control
  - Three status indicator lights



EXAMPLE: THE KLYSTRON SYSTEM

- 16 major components
- CAMAC controls hardware
- Nearly every piece has a control system interface



EXAMPLE: THE KLYSTRON SYSTEM

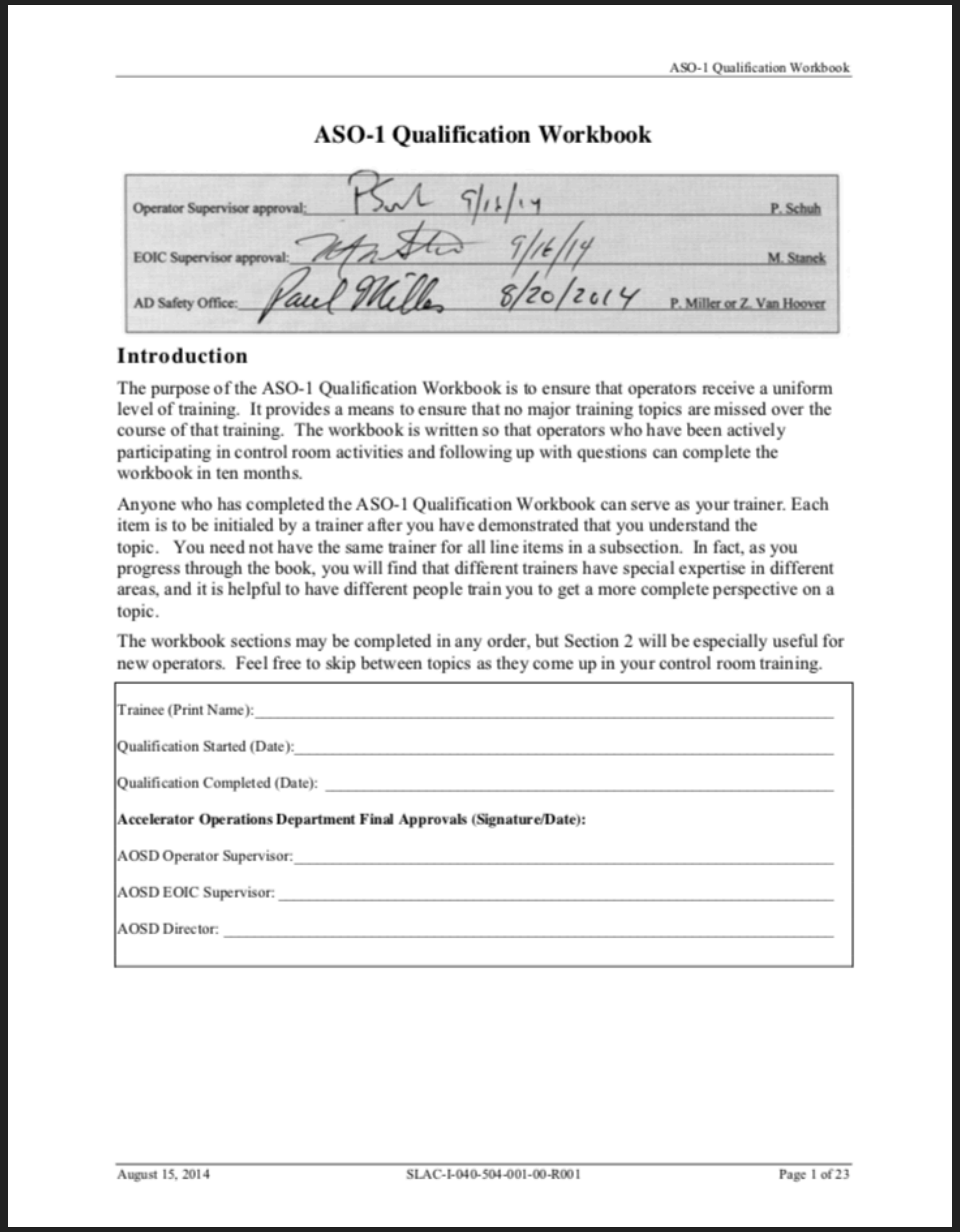
- 23 major components
- CAMAC and VME hardware, each using a different control system
- Much of the old phase control hardware still exists, and is controllable, but its purpose has been supplanted by new LLRF system

MITIGATING COMPLEXITY

- “Operations Klystron Panel” UI that handles some of the differences between old and new-style stations, providing a single interface
- Documentation in our Operations Wiki
- Training
- But, still pretty challenging.

STRATEGIES FOR DEALING WITH OLD AND COMPLICATED SYSTEMS

Training


ASO-1 Qualification Workbook

ASO-1 Qualification Workbook

Operator Supervisor approval: PSchuh 9/12/14 P. Schuh
EOIC Supervisor approval: M. Stanek 9/16/14 M. Stanek
AD Safety Office: Paul Miller 8/20/2014 P. Miller or Z. Van Hoover

Introduction

The purpose of the ASO-1 Qualification Workbook is to ensure that operators receive a uniform level of training. It provides a means to ensure that no major training topics are missed over the course of that training. The workbook is written so that operators who have been actively participating in control room activities and following up with questions can complete the workbook in ten months.

Anyone who has completed the ASO-1 Qualification Workbook can serve as your trainer. Each item is to be initialed by a trainer after you have demonstrated that you understand the topic. You need not have the same trainer for all line items in a subsection. In fact, as you progress through the book, you will find that different trainers have special expertise in different areas, and it is helpful to have different people train you to get a more complete perspective on a topic.

The workbook sections may be completed in any order, but Section 2 will be especially useful for new operators. Feel free to skip between topics as they come up in your control room training.

Trainee (Print Name): ____________
Qualification Started (Date): ____________
Qualification Completed (Date): ____________
Accelerator Operations Department Final Approvals (Signature/Date):
AOSD Operator Supervisor: ____________
AOSD EOIC Supervisor: ____________
AOSD Director: ____________

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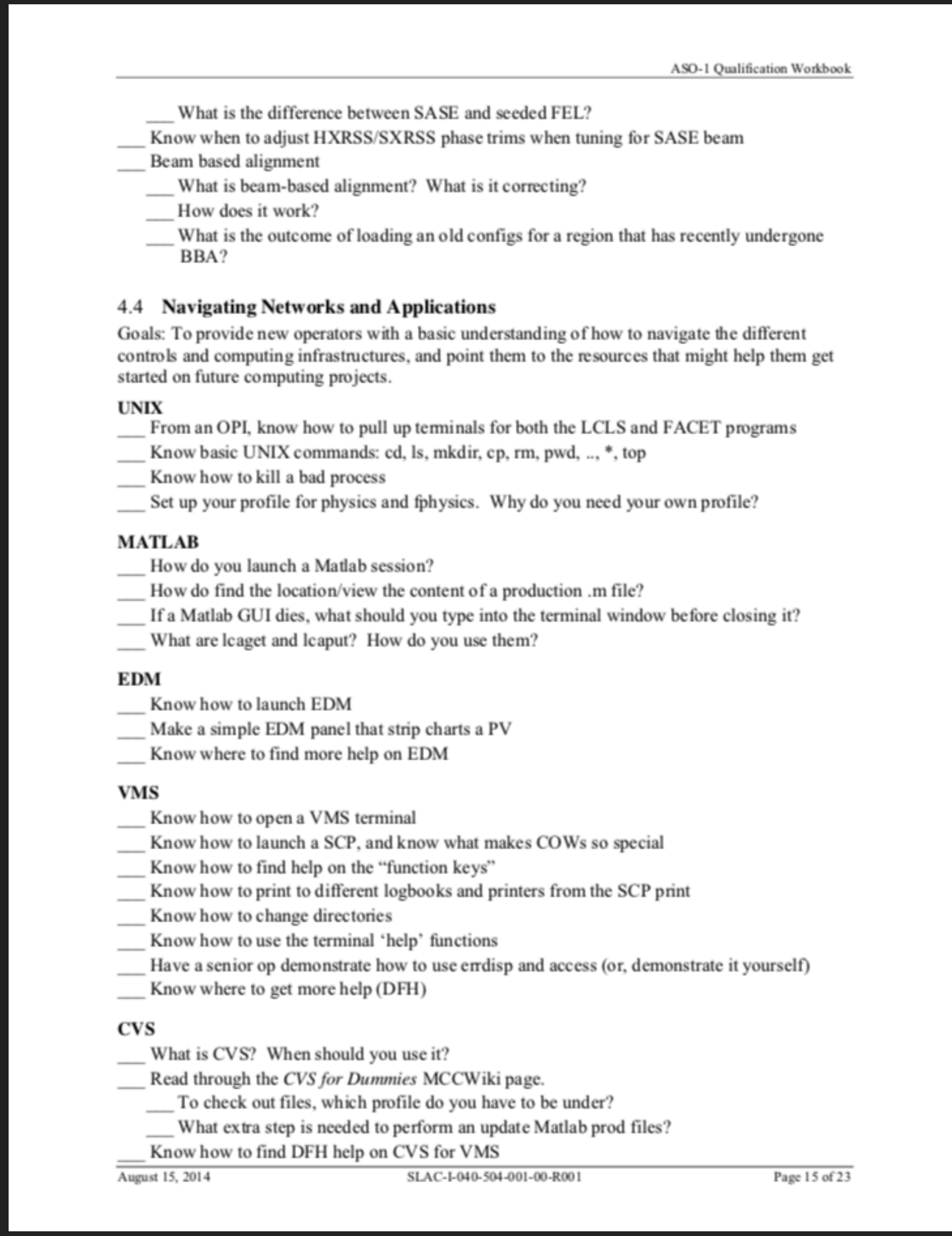
ASO-1 Qualification Workbook

___ What is the difference between SASE and seeded FEL?
___ Know when to adjust HXRSS/SXRSS phase trims when tuning for SASE beam
___ Beam based alignment
___ What is beam-based alignment? What is it correcting?
___ How does it work?
___ What is the outcome of loading an old configs for a region that has recently undergone BBA?

4.4 Navigating Networks and Applications

Goals: To provide new operators with a basic understanding of how to navigate the different controls and computing infrastructures, and point them to the resources that might help them get started on future computing projects.

UNIX
___ From an OPI, know how to pull up terminals for both the LCLS and FACET programs
___ Know basic UNIX commands: cd, ls, mkdir, cp, rm, pwd, .., *, top
___ Know how to kill a bad process
___ Set up your profile for physics and fphysics. Why do you need your own profile?

MATLAB
___ How do you launch a Matlab session?
___ How do find the location/view the content of a production .m file?
___ If a Matlab GUI dies, what should you type into the terminal window before closing it?
___ What are lcaget and lcaput? How do you use them?

EDM
___ Know how to launch EDM
___ Make a simple EDM panel that strip charts a PV
___ Know where to find more help on EDM

VMS
___ Know how to open a VMS terminal
___ Know how to launch a SCP, and know what makes COWs so special
___ Know how to find help on the "function keys"
___ Know how to print to different logbooks and printers from the SCP print
___ Know how to change directories
___ Know how to use the terminal 'help' functions
___ Have a senior op demonstrate how to use errdisp and access (or, demonstrate it yourself)
___ Know where to get more help (DFH)

CVS
___ What is CVS? When should you use it?
___ Read through the *CVS for Dummies* MCCWiki page.
___ To check out files, which profile do you have to be under?
___ What extra step is needed to perform an update Matlab prod files?
___ Know how to find DFH help on CVS for VMS

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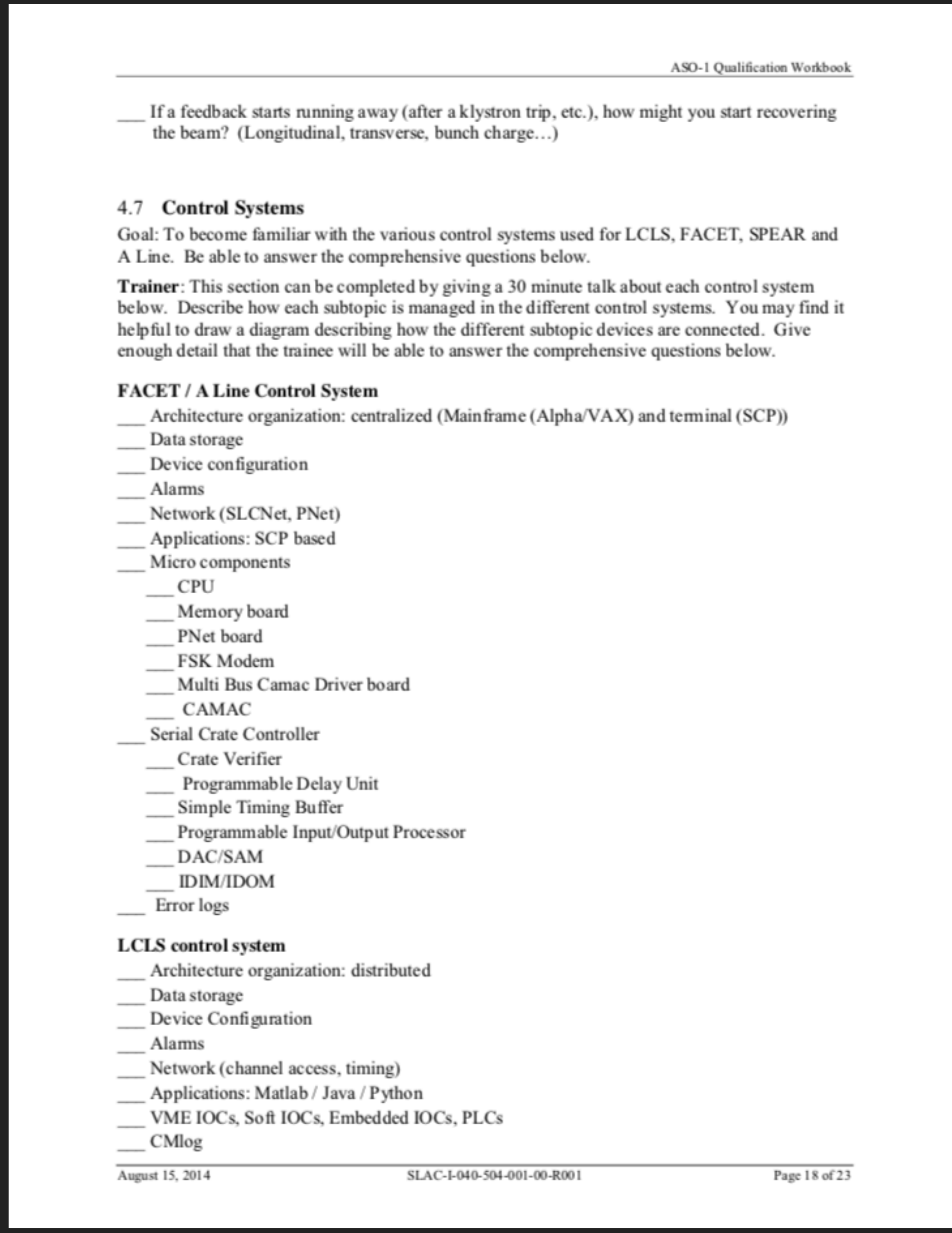
ASO-1 Qualification Workbook

___ If a feedback starts running away (after a klystron trip, etc.), how might you start recovering the beam? (Longitudinal, transverse, bunch charge…)

4.7 Control Systems

Goal: To become familiar with the various control systems used for LCLS, FACET, SPEAR and A Line. Be able to answer the comprehensive questions below.

Trainer: This section can be completed by giving a 30 minute talk about each control system below. Describe how each subtopic is managed in the different control systems. You may find it helpful to draw a diagram describing how the different subtopic devices are connected. Give enough detail that the trainee will be able to answer the comprehensive questions below.

FACET / A Line Control System
___ Architecture organization: centralized (Mainframe (Alpha/VAX) and terminal (SCP))
___ Data storage
___ Device configuration
___ Alarms
___ Network (SLCNet, PNet)
___ Applications: SCP based
___ Micro components
___ CPU
___ Memory board
___ PNet board
___ FSK Modem
___ Multi Bus Camac Driver board
___ CAMAC
___ Serial Crate Controller
___ Crate Verifier
___ Programmable Delay Unit
___ Simple Timing Buffer
___ Programmable Input/Output Processor
___ DAC/SAM
___ IDIM/IDOM
___ Error logs

LCLS control system
___ Architecture organization: distributed
___ Data storage
___ Device Configuration
___ Alarms
___ Network (channel access, timing)
___ Applications: Matlab / Java / Python
___ VME IOCs, Soft IOCs, Embedded IOCs, PLCs
___ CMlog

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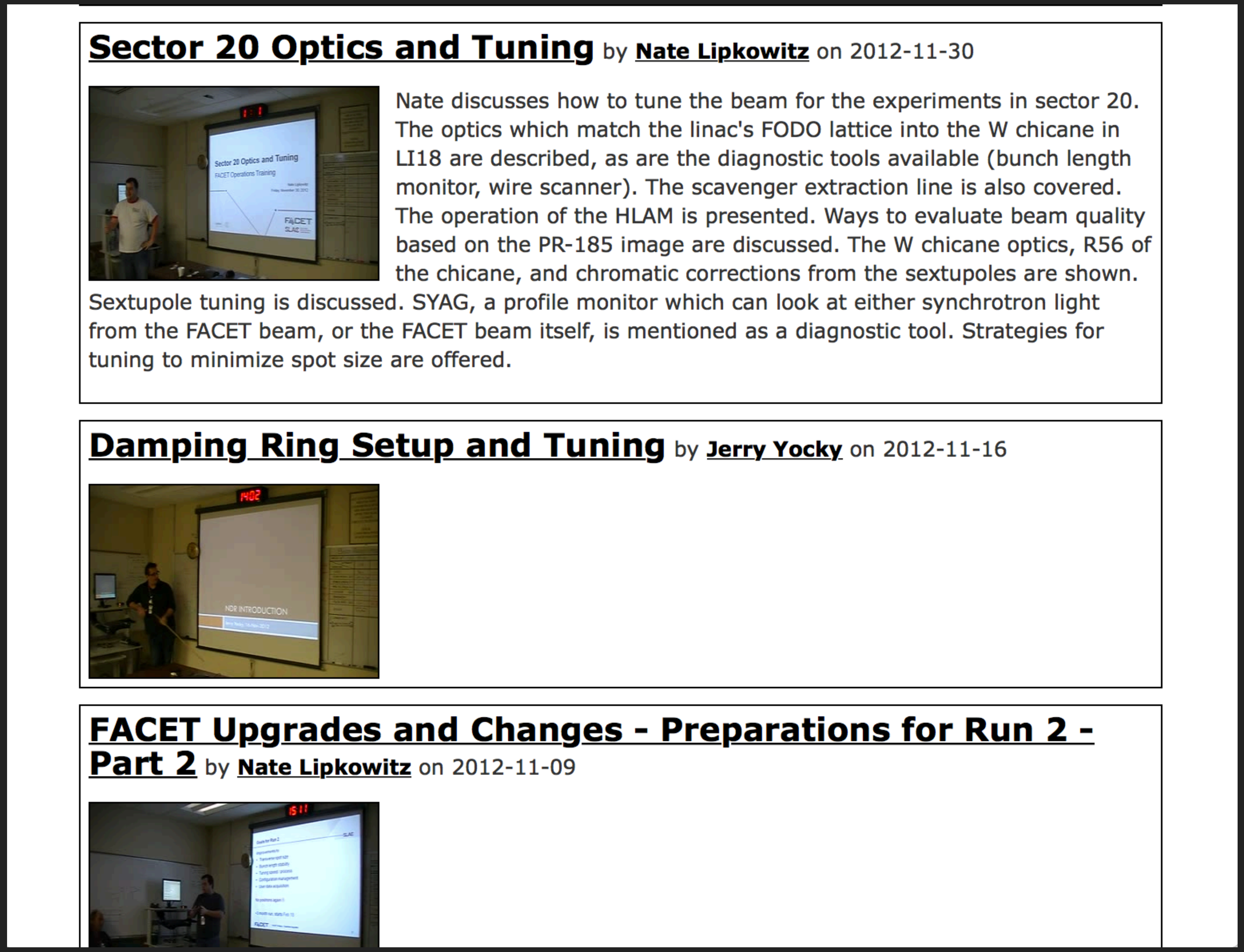
Excerpts from the "ASO-1 Qualification Workbook"

STRATEGIES FOR DEALING WITH OLD AND COMPLICATED SYSTEMS

Documentation

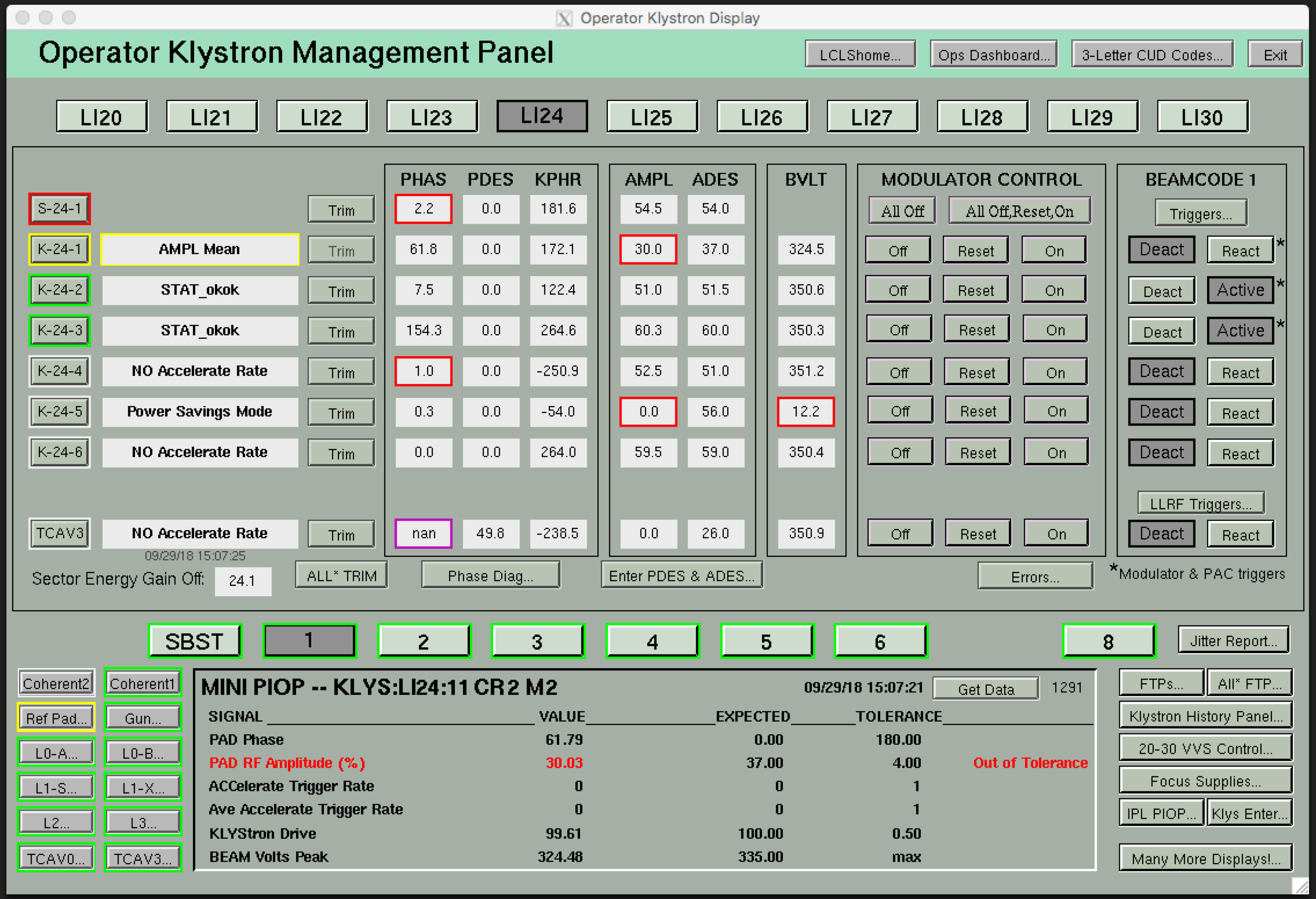
Operations Group Wiki



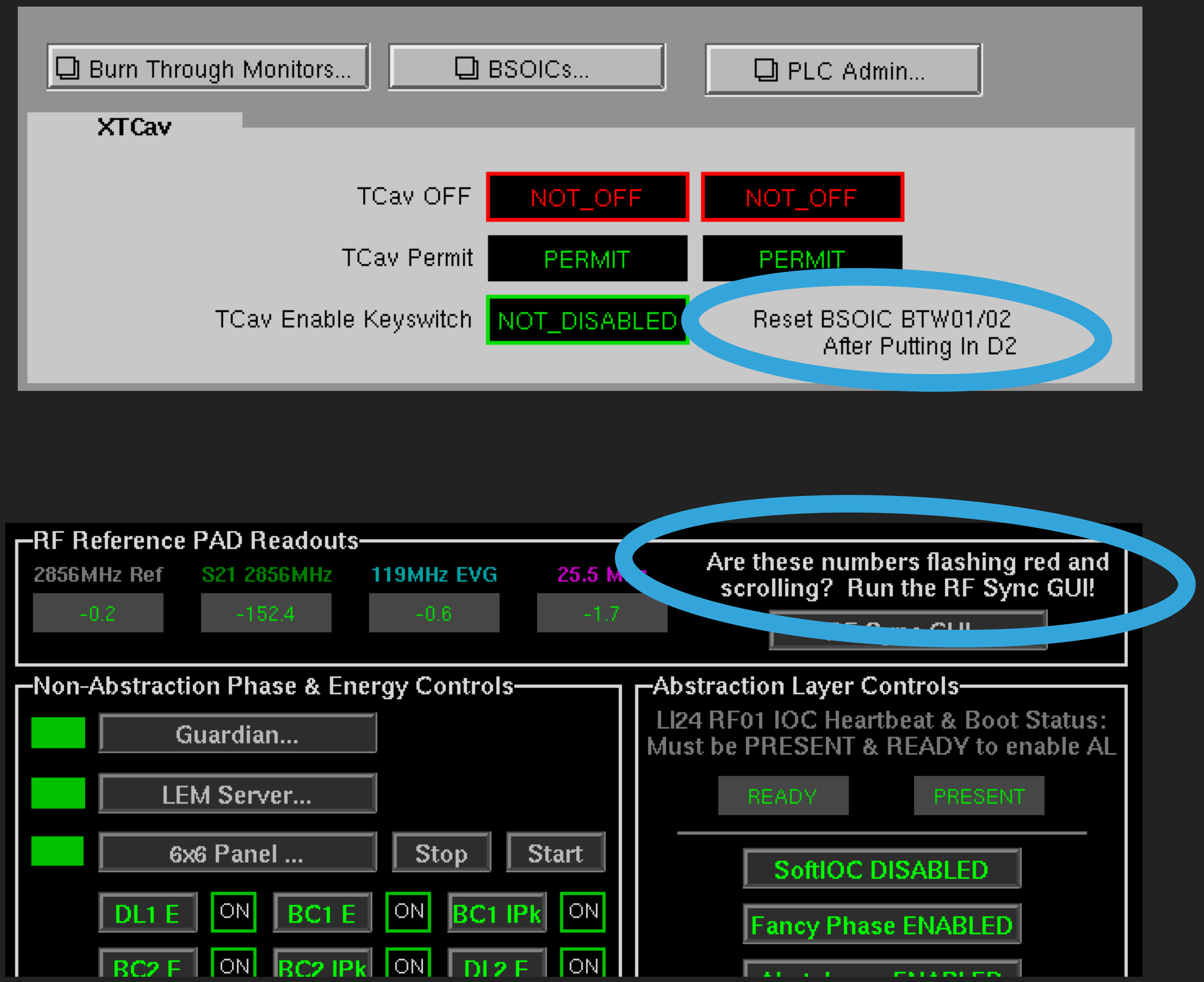
"MCCVideos" Video Database

STRATEGIES FOR DEALING WITH OLD AND COMPLICATED SYSTEMS

Operator-created (or operator edited) Control System Displays



Operator Klystron Panel



Reminder notes written on control panels

THANKS!

Acknowledgements:

- Howard Smith, Peter Schuh, William Colocho, Danielle Sanzone, and Lauren Alsberg for their helpful conversations about this subject
- Vikram Tharakan for the Wolf Box wiki page
- Shawn Alverson for the gigantic flashing “PPYY” text